Grand Canyon State Electric
Cooperative Association, Inc.
Your Touchstone Energy® Cooperatives

March 11, 2014

Docket Control
Arizona Corporation Commission
1200 W. Washington
Phoenix, AZ 85007

Re: *Cooperatives' Comments in the Innovations and Technical Developments Area;*

Docket No. E-00000J-13-0375

Dear Sir/Madam:

The Grand Canyon State Electric Cooperative Association ("GCSECA"), on behalf of its Arizona cooperative members,[1] submits the attached comments in response to Commissioner Bob Burns letter dated December 5, 2013. Commissioner Burns requests information on six major innovations and technological areas.

Attached is a list of research projects and reports in these six areas which have been completed by the Cooperatives' national research organization, the Cooperative Research Network ("CRN"). Through these and other efforts, the CRN demonstrates the Cooperatives' commitment to research on innovations and technologies which can be used when it is cost

[1] The Arizona cooperative members are: Arizona Electric Power Cooperative; Southwest Transmission Cooperative; Duncan Valley Electric Cooperative, Inc.; Graham County Electric Cooperative, Inc.; Mohave Electric Cooperative, Inc.; Navopache Electric Cooperative, Inc.; Sulphur Springs Electric Cooperative, Inc.; and Trico Electric Cooperative, Inc. (collectively the "Cooperatives").

effective to do so. For example, our Cooperatives have been installing innovative technologies such as AMI/AMR metering technology for over a decade. However, there are several limitations to adopting some innovations.

A primary limitation is the Cooperative and its members' ability to afford these technologies so that purchase, installation and operation can be included in loan packages and operating budgets. Another is the risk of adopting innovations too early or too late and the negatives/potential perils associated with both. Obviously, Cooperatives' Boards and Management make the best, most informed decisions they can about whether and when to adopt technologies so that the interests of their members are best met.

In conclusion, the Cooperatives hope this information helps and look forward to the discussion that will take place during workshops on this matter.

RESPECTFULLY SUBMITTED this 11th day of March, 2014.

GRAND CANYON STATE ELECTRIC
COOPERATIVE ASSOCIATION

By ______________________

John Wallace
CEO

Original and 13 copies filed with Docket Control this 11th day of March, 2014, with:

Docket Control
Arizona Corporation Commission
1200 West Washington
Phoenix, Arizona 85007

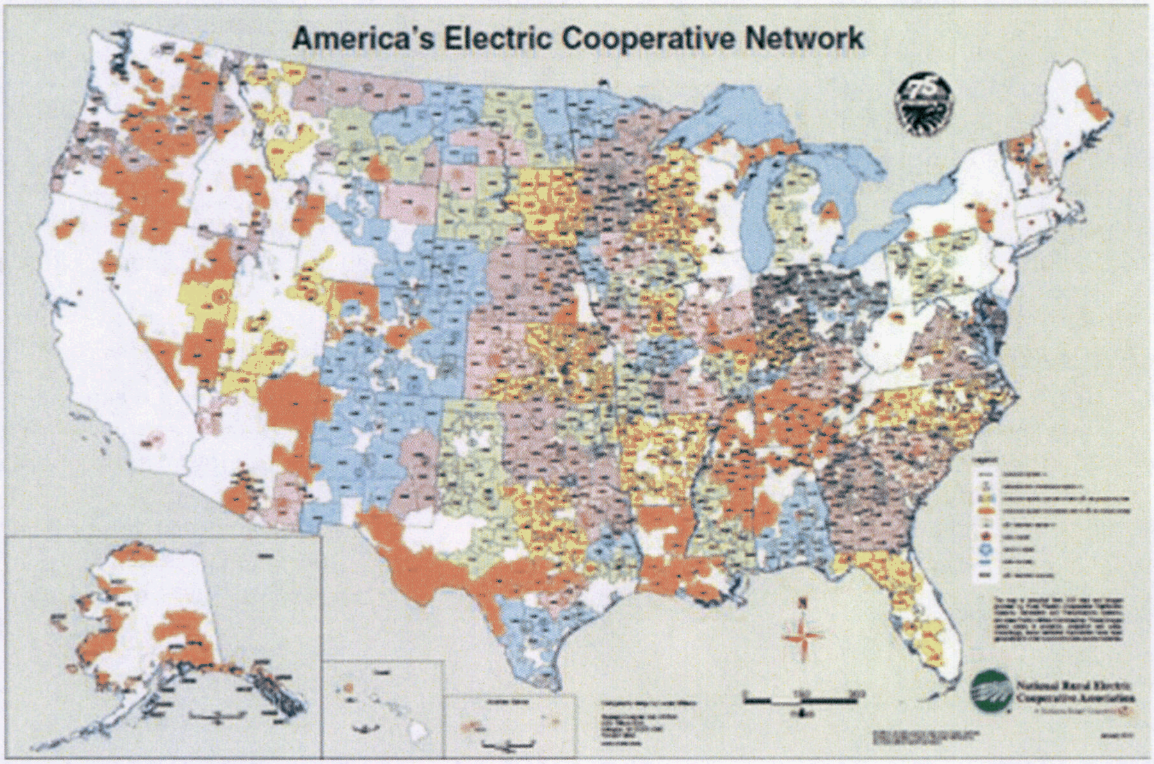
March 7, 2014

CRN
Cooperative Research Network

Cooperative Research Network (CRN)
Technology Research
Response to Arizona Commission Questions

The Cooperative Research Network® (CRN), the technology research arm of the National Rural Electric Cooperative Association (NRECA), conducts collaborative research to accelerate technological innovation that can be applied by electric cooperatives worldwide. The more than 900 co-ops nationwide comprise a real-world test bed for demonstrating the viability of emerging technologies.

NRECA co-op members serve over 42 million Americans in 47 states, cover 75 percent of the nation's land mass, own 42 percent of all Distribution lines, maintain 2.4 million line miles, are powered by 55,000 MW, and deliver 178 billion kWh of generation annually.



(For map source information, please see http://www.nreca.coop/about-electric-cooperatives/co-op-facts-figures/)

4301 WILSON BOULEVARD | ARLINGTON, VA 22203-1860 | 703.907.5843
WWW.COOPERATIVE.COM/CRN *(membership website)* | WWW.NRECA.COOP *(public website)*
National Rural Electric Cooperative Association
A Touchstone Energy® Cooperative

CRN®

Cooperative Research Network

NRECA and CRN work with this broad co-op network, to conduct collaborative research to accelerate technological innovation that can be applied by electric cooperatives worldwide, through:

- Innovation
- Demonstration
- Application

Partnering with co-ops, national labs, academic institutions, and industry, CRN research engages industry experts to meet the needs of cooperatives and their consumer members. CRN's guides, publications, and online tools help cooperatives meet their members' expectations for affordable, reliable electric power using the most advanced technologies available. More about CRN may be found on the member website (cooperative.com) or public NRECA site (nreca.coop).

U.S. Cooperative Research and Technical Communications Around Strategic Critical Issues

Active research Programs, including federally funded research projects in smart grid, solar PV, and grid analytics are underway. The CRN research portfolio addresses strategic issues including:

- Consumer Energy Solutions
- Renewable Energy
- Generation & Environment
- Grid Analytics
- Resiliency
- Cyber Security
- Smart Grid
- Technology Surveillance

Details of DOE-NRECA Active Research may be found in the Appendix to this report, along with a two-page summary of CRN work with the DOE Smart Grid Demonstration.

Research Priorities Set with Co-op Advisor Input

CRN's 100 member advisors, drawn from the extensive network of not-for-profit, consumer-owned cooperatives, identify and help CRN expand on the most important areas for research, and challenge CRN to develop research, alliances, and communications supporting cooperatives' research priorities. The six Membership Advisory Groups are:

- Distribution Operations
- Energy Innovations
- Generation, Fuels, and Environment
- Renewable and Distributed Energy
- Smarter Grid
- Transmission and Substation Assets

CRN Partners

CRN collaborates with many organizations and experts, including:

- U.S. Department of Energy
- National laboratories
- Industry & manufacturing
- Universities and research centers
- EPRI
- ESource
- NEETRAC
- CEATI
- DSTAR

Sharing Technology Research and Insights with Members

CRN publications, videos, and materials are available to cooperatives on a member website, cooperative.com.

- Guides and handbooks
- Technical Reports
- Technical Articles
- Product evaluations
- Webinars & workshops
- Publications and videos
- Consumer education

CRN *TechUpdate* Electronic Newsletter

CRN issues a twice-monthly electronic newsletter, *TechUpdate*, to notify members of new reports and other offerings from CRN. (A sample of TechUpdate is included in the Appendix to this document.) The distribution for this newsletter is established based on job codes in our membership database, and includes functions deemed as likely most interested in technology research, such as Engineering, Operations, Management, Key Accounts and Customer Service. Approximately 20,000 co-op members nationwide are currently on the distribution list. However, any NRECA co-op member may sign-up for and receive *TechUpdate* through a request link on Coop.com or by directly contacting CRN.

Approximately 350 co-op members in Arizona currently receive *TechUpdate*, as shown in the table below.

Arizona Co-op	**Members Receiving CRN TechUpdate**
Ak-Chin Energy Services	1
Arizona Electric Power Co-op, Inc	11
Duncan Valley Electric Cooperative, Inc	4
Electrical District #2	6
Electrical District #5, Pinal County	3
Gila River Community Utility Authority	4
Graham County Electric Cooperative, Inc.	9
Grand Canyon State Electric Co-op	7
Great Lakes Energy Cooperative	1
Mohave Electric Co-op, Inc.	16
Navajo Tribal Utility Authority	82
Navopache Electric Co-op, Inc.	36
Peace River Electric Cooperative, Inc.	1
Prime Process Management	1
Sierra Southwest Cooperative Services, Inc.	53
Southwest Transmission Cooperative, Inc.	17
Sulphur Springs Valley Elec. Co-op	51
Tohono O'odham Utility Authority	21
Trico Electric Cooperative, Inc.	24
TOTAL	**348**

TechAdvantage Conference and Expo

CRN participates annually in national conferences, at which we provide workshops, booth displays, and networking opportunities through which CRN technology research results are further disseminated to members. This year's NRECA *TechAdvantage Conference and Expo*, occurring March 3-6 in Nashville, TN, includes CRN workshops on topics including Grid Resiliency, Open Modeling Framework, Cyber Security, Solar PV, Energy Storage, Smart Feeder Switching, Next Generation IT Architecture, System Loss Reduction, among others.

This year's *TechAdvantage Expo* will also feature nearly 300 exhibitors, who will showcase their state-of-the-art equipment and services for co-ops. Attendees will not only learn why to employ new technology through conference educational sessions, they will see what that technology looks like and how it works through hands-on sessions and in-depth conversations with exhibitors at the Expo.

More about *TechAdvantage Conference and Expo* may be found at: http://www.techadvantage.org/. A listing of the technology workshops being offered at *TechAdvantage* this year appears in the Appendix of this document. Please note that beyond these 'Learning Labs' and 'Technovation sessions,' CRN is staffing a booth in the Exhibit hall to provide one-on-one discussions with co-op attendees and demonstrations of resent technology research and tools.

CRN and Co-ops, Partnering in Active Research Demonstrations

A key part of CRN research is testing new technology in field demonstrations. The vast co-op network representation across the country creates a robust living laboratory for real-life testing. To date, CRN has worked with co-ops for over 70 technology demonstrations in 31 states, as shown in the map included in the Appendix to this report.

For more information about CRN:

Please see NRECA's website at: www.nreca.coop

Contact Robbin Christianson, Senior CRN Program Operations & Business Management: robbin.christianson@nreca.coop

CRN®
Cooperative Research Network

CRN Research Related to Arizona Commission's Specific Areas of Interest

1. **Distributed Supply and Storage Resources Enabling Customer Self-Supply:** includes any distributed supply resources (solar technologies, fuel cell, etc); distributed storage devices (batter, flywheel, thermal storage, etc); and customer shared generation (virtual net metering, etc – excludes rate design issues being dealt with in Docket No. E-01345A-13-0248).

   Since its inception, CRN has tracked distributed generation and energy storage technologies.

   On the storage side, CRN is tracking the costs and developments of the small-scale and residential-sized battery systems. To date, energy storage – specifically paired with a rooftop photovoltaic system – is still cost prohibitive to all but a niche market. This may change with the recent entry of leased energy storage systems being paired with leased PV systems.

   Completed Research

   - <u>**Energy Storage in the Future Grid**</u>
     - Looks at how energy storage systems have the potential to revolutionize the electrical grid, especially as new renewable generation is added to the existing generation fleet.
   - <u>**Case Study: Energy Storage for Irrigation**</u>
     - Sulphur Springs Valley Electric Coop (SSVEC), in southeast Arizona, serves more than 400 irrigation pumps in its territory and is looking to energy storage as one option for dealing with capacity constraints as it experiences growth in irrigation and other loads. This case study report details their experiences and explains the financial impact of installing battery energy storage systems to support irrigation.
   - <u>**Utility Engagement with Emerging Storage Technologies**</u>
     - Provides an overview of a variety of energy storage technologies on today's grid and looks at the viability of various technology options.

   On the distributed generation side, CRN has completed an assessment of most distributed generation technologies that have attempted commercialization, such as fuel cells, micro-turbines, stirling engines – as well as traditionally renewable technologies, such as small scale wind, solar, geothermal, and hydro.

   In terms of non-renewable, fuel powered generators, we have not seen any applications that can economically compete with traditional small generators using natural gas, propane, diesel, or gasoline. The traditional generator described above is a well-established commercial product. As such, CRN is not engaged in any research on this technology outside of its role as a baseline technology in terms of cost and performance, or the role of traditional generators in combination with other technologies, including novel applications such as a Microgrid or virtual power plants.

Completed Research

- **The Virtual Power Plant: A Concept Worth Exploring**
  - Demand response, popular in the 1990s, is once again attracting attention. Several factors — transmission constraints, soaring natural gas prices, and growing electricity demand — have sparked renewed interest in this concept. With the passage of the Energy Policy Act of 2005, Congress pushed demand response into the spotlight, essentially making it a national policy.

- **Residential Fuel Cell Demonstration**
  - The purpose of this study was to give co-ops a first-hand assessment of how well fuel cells perform in residential service and how much they cost to buy and operate.

The biggest area of research on consumer-sided generation relates to renewables. There has been a massive uptake in renewable penetration globally and co-ops are a part of this. This has been driven almost completely by residential PV, as CRN has found that small wind deployments are difficult to make economic. CRN's research is focused on helping co-ops understand the impacts of large penetrations of variable generation on the grid, assess and mitigate the impacts, and track the technology so that coops can make strategic policy decisions.

Completed and Current Research

- **Webinars: Utility Solar Trends part 1 and 2**
  - Doug Danley, technical liaison and consultant to NRECA, shared industry updates on electric co-ops and solar practices. This session provided details on the basics of solar technology, as well as the current status of applications in the residential market.

    https://www.cooperative.com/conferences/webconferences/PastWebConferences/CRNSolar/Pages/default.aspx

    https://www.cooperative.com/conferences/webconferences/PastWebConferences/Pages/CRNSolarWebinarSeriesUtilitySolarTrends.aspx

- **SUNDA**
  DOE grant funded project; it creates standardized Utility Scale Solar designs to enable simplified acquisition and integration as well cost reductions via group purchasing opportunities.

- Cooperative Residential PV Guide: Addressing small-scale consumer photovoltaics systems
  This guide strives to provide background knowledge, tools, and quotable advice that will help our members maintain objective discussions with their consumers to inform them of the accurate costs and benefits of residential solar generation.

- Technical and Market Assessment of Emerging Energy Technologies
  This report helps readers to keep abreast of the latest advances in energy technologies. The report includes both technical and market reviews to give the reader a more complete picture of each technology.

- Strategic Solar Opportunities For Electric Cooperatives (PV Technologies, Market Trends, Business Models, and Economics)
  This report looks at how in the past ten years, the market for solar photovoltaics (PV) has shifted from a focus on supplying small amounts of electricity directly to loads beyond the reach of the grid, to becoming a significant source of new generation.

- Tools to Assess the PQ Impact of Large Penetrations of Modestly Rated DG on Distribution Feeders
  This report assesses the impact of large penetrations of modestly rated distributed generating (DG) resources where individually rated generators are less than around 100 kW and applied as single-phase installations

- Strategies for Energy Utilities to Address Emerging Sustainable Neighborhood Development Trends
  This report, through the use of workshops and the review of existing green communities, describes the nature of the dynamic landscape for utilities in North America. It identifies the risks and opportunities for utilities, specifically related to the growth of green communities. Opportunities discussed include business concepts, regulatory changes, and technical solutions.

- Interconnecting Solar, Wind, and other DG Resources
  This project helps co-op engineers and technical staff address consumer-member questions and requests for interconnection of solar, wind and other distributed generation.

2. **Customer Load Management Technology, Energy Efficiency, Major New Loads and Related Services:** includes customer energy information systems, demand controllers, real-time pricing controls, plug-in electric vehicles, demand response, and alternative service arrangements for customer energy management, etc.

   Resource planning for capital-intensive industries supplying universal, essential services to the public has always required a delicate balance between supply and demand to ensure an appropriate combination of safety, reliability, and cost-effectiveness. For electricity supply in the United States, both the traditional view of the industry as a natural monopoly and intensified awareness of the environmental impact of generation choices clearly mandate both public and private sector involvement in these choices. The research, software, and personnel resources devoted to DSM evaluation reached its apex 25 years ago, when IRPs were a central focus of utility planning. Today, experienced staff possessing a relevant arsenal of tools to meet current challenges is scarce.

   Energy efficiency and demand response are critical focal points for cooperatives in their immediate future planning efforts. Changing market conditions may dictate these programs to increase energy efficiency, reduce system peak, increase system resiliency, support strategic energy sales, foster adoption of micro grids and consumer owned generation, or all of the above. This scattered approach requires a comprehensive DSM research portfolio.

Change is constantly happening. However, the rapid rate of changes to the utility business model in the past few years is expected to continue. These changes will require a renewed look at rates, quality-of-life service offerings, leveraging utility infrastructure to provide added value to DSM programs, and strengthening the co-op/member relationship.

Electric cooperatives have engaged their research arm, the Cooperative Research Network, over the past several years to examine disruptive technologies and determine their role in cooperative programs. It is critical to point out that the role of the utility in influencing technology adoption may be limited. Retailers, popular media, manufacturers, and others all play a role in what technologies ultimately gain market share and popularity. It is the role of the utility to determine if issues such as harmonics or demand require action by the utility. The utility also has a critical role in exploring how end use devices are incorporated in demand response programs.

2014 Upcoming Research

- Using Electric Service Plans to Promote Energy Savings Behavior
- The Role of Smart Thermostats in a Demand Response Program
- How Third Parties May Impact the Co-op/Member R elationship
- Future of Energy Usage Presentment
- Low Cost Load Monitoring
- Demand Response Communication Protocols
- Electrification of Transportation

Customer Information Systems

Cooperatives across the nation have invested in energy usage portals, online bill presentment tools, and mobile web sites to improve communication about energy usage between the co-op and co-op consumers. The type of tool and the effectiveness are largely dependent upon the sophistication of consumers and the Internet and cellular technology available in a service territory. The impact to energy usage of participants is often small at best. Most consumers use these tools to view outage information and restoration time.

Research Output

- Evaluating the Effectiveness of Third-Party, Web-Based Energy Use Portals and Their Impact on Energy Efficiency Programs, May 2011
  https://www.cooperative.com/InterestAreas/CRN/ProductsServices/Reports/Pages/ThirdPartyWebBasedEnergyUsePortals.aspx

- Determining the Effectiveness of In-Home Energy Use Displays, February 2008
  https://www.cooperative.com/InterestAreas/CRN/ProductsServices/Reports/Pages/EvaluationofIn-HomeDisplays.aspx

- Mobile Web Sites Can Meet Co-op Members' Need for 24/7 Access, January 2001 https://www.cooperative.com/InterestAreas/CRN/ProductsServices/CRN/Documents/MobileWebSites.pdf

Demand controllers

Demand controllers are a critical technology to help cooperatives and other electric utilities to lower energy usage during peak times. This space is currently undergoing a shift from traditional one-way controllers to two-way controllers that will verify that the device being activated is actually under control. There is little agreement on the standards, communication technology, or control logic that should be used. Pilot projects are recommended at this time. Most co-ops will need to use a variety of technologies in order to reach the maximum number of participants. This will increase program costs.

Research Output

- Demand Response and Critical Peak Pricing: Testing the Theoretical Basis for DR, November 2013 http://www.nreca.coop/wp-content/uploads/2014/01/NRECA_DOE_DR_CPP_a.pdf

- Can Smart Thermostats Rise from the Ashes of Their Programmable Predecessors?, December 2012 https://www.cooperative.com/InterestAreas/CRN/ProductsServices/CRN/Documents/CanSmartThermostatsRise.pdf

Real time pricing controls

There is a mountain of research around real time pricing. Real time pricing works best when consumers have technologies within their homes that can automate response to price signals. Most of this technology has yet to find its way into stores, and costs tend to be high. Cooperatives have piloted and tested alternative pricing schemes that reward consumers for changes in energy usage.

Research Output

- Can Smart Thermostats Rise from the Ashes of Their Programmable Predecessors?, December 2012 https://www.cooperative.com/InterestAreas/CRN/ProductsServices/CRN/Documents/CanSmartThermostatsRise.pdf

- Demand Response and Critical Peak Pricing: Testing the Theoretical Basis for DR, November 2013 http://www.nreca.coop/wp-content/uploads/2014/01/NRECA_DOE_DR_CPP_a.pdf

Plug-in electric vehicles

Plug-in electric vehicles have the potential to be a disruptive technology if steps are not taken by electric utilities. EVs can reduce the life of distribution transformers, if charged during system peak via level 2 or higher charger. This is the equivalent of adding an additional home to the transformer. Current systems are not designed for this unpredictable load. A small number of co-ops around the nation have implemented special rates for electric vehicle consumers. These rates charge a significantly higher rate during peak and encourage charging during the night. Ultimately, whether or not electric vehicles become successful depends on auto manufacturers' ability to develop cars that address concerns over battery life, are viewed by consumers as cost effective, and meet the general automotive needs of consumers.

Research Output

- Plug-In Electric Vehicles, April 2013, https://www.cooperative.com/InterestAreas/CRN/ProductsServices/Reports/Documents/Plug-InElectricVehicles.pdf
- Electric Vehicle Supply Equipment, July 2013 https://www.cooperative.com/InterestAreas/CRN/ProductsServices/Reports/Documents/ElectricVechicleSupplyEquipment.pdf
- Level 3 Charging Systems for EV Now Commercially Available, October 2013 https://www.cooperative.com/InterestAreas/CRN/ProductsServices/TechSurveillanceMagazine/archives/Pages/Level3ChargingSystemsforEVNowCommerciallyAvailable.aspx
- Plug-in Electric Vehicles as Load, April 2013 https://www.cooperative.com/InterestAreas/CRN/ProductsServices/TechSurveillanceMagazine/archives/Documents/TS_PEVs_as_Load.pdf
- The Changing Nature of Loads and Impact on Utilities, April 2010 https://www.cooperative.com/InterestAreas/CRN/ProductsServices/Reports/Pages/TheChangingNatureofLoadsandImpactonUtilities.aspx

Demand response

Demand response is increasing in importance as a tool for lower consumer costs. Cooperatives have field tested several technologies to improve the effectiveness of demand response. The effectiveness of a demand response program is a combination of the market that the utility participates in, the type of load being served, and available generation resources. Utilities with substantial commercial and industrial loads will have more effective demand response programs. Cooperatives tend to rely on residential HVAC and water heating. New smart home technology may be able to add small amounts of capacity to demand response programs. But the cost to add those small loads may be higher than the value.

Research Output

- Increasing Load Management Opportunities With Advanced Metering Infrastructure, January 2013 https://www.cooperative.com/InterestAreas/CRN/ProductsServices/CRN/Documents/IncreasingLoadManagementOpportunitiesAMI.pdf

- Can Smart Thermostats Rise from the Ashes of Their Programmable Predecessors?, December 2012 https://www.cooperative.com/InterestAreas/CRN/ProductsServices/CRN/Documents/CanSmartThermostatsRise.pdf

- The Value of Improving Load Factors through Demand Side Management Programs, March 2013 https://www.cooperative.com/InterestAreas/CRN/ProductsServices/CRN/Documents/TheValueofImprovingLoadFactorsthroughDemandSideManagementPrograms.pdf

- Guide to the Essentials of Energy Efficiency and Demand Response Programs, June 2009 https://www.cooperative.com/InterestAreas/CRN/ProductsServices/Reports/Pages/GuideEnergyEfficiencyandDemandResponsePrograms.aspx

Alternative power arrangements for customer energy management

The use of third-parties for energy management is an action that often does not serve residential customers well. The past several years has seen several third-parties come and go in the energy management field. This service tends to benefit commercial and industrial accounts. Cooperatives have successfully implemented alternative programs, such as prepay metering and on-bill financing programs. These have successfully been shown to lower energy usage and raise customer satisfaction.

Research Output

- How the Non-Energy Benefits of Energy Efficiency Can Help Co-ops, September 2013 https://www.cooperative.com/InterestAreas/CRN/ProductsServices/CRN/Documents/Non%20Energy%20Benefits%20of%20Energy%20Efficiency.pdf

- Can Smart Meters Make Prepaid Work for You?, January 2012 https://www.cooperative.com/InterestAreas/CRN/ProductsServices/Reports/Pages/CanSmartMetersMakePrepaidWorkforYou.aspx

- Prepaid Metering Analytical Report, June 2012 https://www.cooperative.com/InterestAreas/CRN/ProductsServices/Reports/Documents/PrepaidMetering.pdf

- Conservation Impact of Prepaid Metering: Motivation and Incentives for pre-Pay Systems, November 2013 http://www.nreca.coop/wp-content/uploads/2014/01/NRECA_DOE_Prepaid_Metering_c.pdf

Other Relevant Research

- An Introduction to the Economics of Variable Frequency Drives, September 2013
https://www.cooperative.com/InterestAreas/CRN/ProductsServices/CRN/Documents/The%20Economics%20of%20Variable%20Frequency%20Drives.pdf

- Solar Hot Water: A Shining Opportunity to Save Energy, February 2013
https://www.cooperative.com/InterestAreas/CRN/ProductsServices/CRN/Documents/Solar%20Hot%20Water.pdf

- Identifying Cost-Effective Applications for Motor Voltage Controllers, January 2014
https://www.cooperative.com/InterestAreas/CRN/ProductsServices/Reports/Pages/IdentifyingCostEffectiveApplications.aspx

- Innovative Techniques for Taking Emerging Technologies from Discovery to Implementation, January 2014
https://www.cooperative.com/InterestAreas/CRN/ProductsServices/Reports/Pages/InnovativeTechniquesEmergingTech.aspx

- Finding LED Products That Meet Your Needs, December 2013
https://www.cooperative.com/InterestAreas/CRN/ProductsServices/Reports/Pages/FindingLEDProductsThatMeetYourNeeds.aspx

- Case Study: Single Phase Support of Large Irrigation Loads, February 2014
https://www.cooperative.com/InterestAreas/CRN/ProductsServices/TechSurveillanceMagazine/archives/Pages/SinglePhaseSupportLargeIrrigationLoads.aspx

3. **Utility-Scale Storage Technology:** includes pumped storage (hydro, compressed air) battery, flywheel, etc.

   Energy storage deems to be a critical area of research especially as we see higher penetrations of renewables on the grid. While Energy Storage is not a new technology, innovations, improvements and efficiencies have been discovered in the last few years adding complexity in evaluating and selecting the appropriate technology for a utility. NRECA's Cooperative Research Network (CRN) worked with Sandia National Laboratories and the Electric Power Research Institute (EPRI) to update the energy storage handbook that allows a utility to find all the necessary information on storage technology as they evaluate the most appropriate one (http://www.sandia.gov/ess/publications/SAND2013-5131.pdf). CRN also developed a simplified version of the handbook that also offered a process for Requests for Information (RFI) and Requests for Proposals (RFP) relevant to the needs of an electric cooperative as they consider energy storage.

   While energy storage technology is advancing rapidly, CRN continues to monitor, track, and evaluate the different types of technologies, for example, isothermal compressed air storage, and evaluates the economic viability and value proposition of energy storage for electric cooperatives for their respective market conditions.

Research Output:

- Energy Storage Toolkit:

  The Energy Storage Toolkit is intended to help cooperatives assess and implement energy storage solutions, and is comprised of two parts:

  - *Financial Screening for Energy Storage* that provides a structure for calculating the financial benefits (including net present value, return on investment, and simple payback) of energy storage for 17 different applications , as identified in the 2010 Sandia National Laboratory report "Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide".

  - *Procurement Templates* that provide guidance for how to acquire energy storage systems via Request for Proposal (RFP) and Request for Information (RFI) templates.
- Compressed Air Energy Storage – Past, Present and Near Future
  Compressed Air Energy Storage (CAES) is a proven utility-grade and utility-scale technology that time-shifts generation for peak shaving and balancing wind and solar production with demand for electric power. CAES and pumped hydro storage are the only energy storage technologies capable of storing energy on a GW/hour scale, but there are site limitations. This TechSurveillance article looks at the benefits of CAES operating facilities, first- and second-generation technology, and the regulatory changes that will help advance it.

- Energy Storage for Renewable Energy and Transmission and Distribution Asset Deferral
  This project report examines bulk battery energy storage systems (BESS) and evaluates their potential usefulness for renewable energy applications and asset deferral. Eight types of utility-scale batteries are examined.

- Electric Co-ops Considering the Greater Value Proposition of Energy Storage Systems
  This report examines how rural cooperatives around the nation are considering energy storage as a practical means of handling the steadily rising influx of intermittent and non-dispatchable wind and solar power that most states are requiring utilities to use to meet Renewable Portfolio Standards (RPD).

- Energy Storage in the Future Grid
  This report presents a detailed analysis of a matrix of energy storage technologies and identified applications, attempting to develop a business case for the deployment of energy storage within a utility context. Few viable energy storage scenarios can be identified, based on current storage technology, anticipated storage price points, typical utility financing hurdle rates, carbon policy, and renewable penetration level, especially where the storage resource targets a single beneficiary.

4. **Metering Technology & Service:** includes electronic meters, communication systems (one-way, two-way, real-time), alternative arrangements for meter reading, meter services, and meter data management, etc. (excludes health and privacy issues being dealt with in Docket No. E-00000C-11-0328)

   - Advanced Meter Interval Data: Now You Have It, So What Should You Do With It?, December 2013 https://www.cooperative.com/InterestAreas/CRN/ProductsServices/TechSurveillanceMagazine/archives/Documents/TS Interval Data Dec 2013.pdf
   - The Why of Voltage Optimization, January 2013 https://www.cooperative.com/InterestAreas/CRN/ProductsServices/TechSurveillanceMagazine/archives/Documents/TS Volt VAR January2013.pdf
   - Multi-Tenant Meter Data Management: A Systems Approach to Hierarchical Value, November 2013 http://www.nreca.coop/wp-content/uploads/2014/01/NRECA DOE Multi Tenant MDM d.pdf
   - AMI: Value Beyond Meter Reading, January 2008 https://www.cooperative.com/InterestAreas/CRN/ProductsServices/Reports/Pages/AMIValueBeyondMeterReading.aspx
   - Guide to Meter Data Management (MDM) Systems, October 2006 https://www.cooperative.com/InterestAreas/CRN/ProductsServices/Reports/Pages/GuidetoMDMSystems.aspx

5. **Transmission and Distribution Automation:** includes improved real-time information access for situational awareness, real-time physical monitoring and manual control, automated technologies for system self-healing, etc.

   - Communications for Distribution Automation (DA), June 2013 https://www.cooperative.com/InterestAreas/CRN/ProductsServices/TechSurveillanceMagazine/archives/Documents/TS_communications_DA.pdf
   - Smart Feeder Switching, June 2013 https://www.cooperative.com/conferences/webconferences/PastWebConferences/SPCCforGenerationandTransmissionCoops/Documents/TS Smart Feeder Switching July 2013.pdf
   - Considering Going Mobile? Start Here, December 2013 https://www.cooperative.com/InterestAreas/CRN/ProductsServices/TechSurveillanceMagazine/archives/Documents/TS Mobile Devices Dec 2013.pdf
   - Guide to Down Line Automation, June 2005 https://www.cooperative.com/InterestAreas/CRN/ProductsServices/Reports/Pages/GuidetoDownLineAutomation.aspx
   - Down Line Automation 101: An Introduction to Down Line Automation Concepts, October 2006 https://www.cooperative.com/InterestAreas/CRN/ProductsServices/TechSurveillanceMagazine/archives/Pages/AnIntroductiontoDownLineAutomationConcepts.aspx

- Costs and Benefits of Smart Feeder Switching: Quantifying the Operating Value of SFS, November 2013 http://www.nreca.coop/wp-content/uploads/2014/01/NRECA_DOE_Costs_Benefits_SFS_a.pdf
- Costs and Benefits of Conservation Voltage Reduction: CVR Warrants Careful Examination, November 2013 http://www.nreca.coop/wp-content/uploads/2014/01/NRECA_DOE_Costs_Benefits_of_CVR_b.pdf
- Communications: The Smart Grid's Enabling Technology, November 2013 http://www.nreca.coop/wp-content/uploads/2014/01/NRECA_DOE_Communications_b.pdf

6. **Micro-Grids:** includes grid-tied and isolated

The concept of a micro-grid has been around for a long time, but implementation has been limited to date. In general, "microgrid" just means a small grid operated mostly independently from a larger, centralized grid, though microgrids can interact with the larger grid when circumstances dictate, importing or supplying power. Specific definitions are emerging slowly as the concept is explored.

To date, most microgrids have been either experimental or associated with particular localized loads that require very high reliability. The U.S. Military has been a leader in this area, working with a few industrial firms notably Boeing, Siemens, ABB, and SAIC and Lockheed Martin as integrators. Growth of microgrid capacity over the last five years was 22 percent per annum; with this, the CAGR for the next five years is expected to remain at this level with capacity reaching 4.7 GW by 2017.

There are many posited benefits to microgrids, but these have not yet been demonstrated at scale. Among the benefits:

1. Improved reliability
2. More economical integration of renewable and distributed generation
3. Reduced distribution line loses
4. Provision of power in areas that are not readily served by the broader grid
5. Agile, lower capital deployment
6. Overall lower cost (?)
7. Empowerment of energy users with an interest in control.

Whether or not microgrids become a substantial and enduring part of the grid, they are an important consideration for the near and mid-term. Interest has grown immensely in the wake of hurricane Sandy, and the impacted utilities, other utilities, industrial firms, and federal and other research organizations are undertaking aggressive research, development, and demonstration projects, as well as limited commercial deployment.

Although CRN has no published research on this topic to date, Microgrids is a major area of research in our "Grid Resiliency" program. Currently, CRN is investigating how to help co-ops to understand and plan for micro-grids in their service territory, built by the co-op or others.

APPENDIX

DOE-NRECA Active Research

Cyber Security

Innovation for Increasing Cyber Security for Energy Delivery Systems
National Energy Technology Laboratory (NETL)
Energy Sector Security through a System for Intelligent, Learning Network Configuration Management and Monitoring:
On September 19, the Department of Energy announced and award to NRECA of $3.6 million towards a $4.7 million project to develop advanced ant technology which will allow utilities to implement cyber security protection that goes well beyond traditional firewalls while being easier to use and more agile.

Objectives of the Project:
The NRECA Cooperative Research Network project will make utilities more secure by making security management simpler, less costly, and more reliable. The solution is innovative, complementing current methods. This solution is an integrated approach to define, configure, manage, and monitor utility networks with high-fidelity and minimal experience in cyber security. NRECA has done extensive work in building processes for continuous improvement of the security of the subject utilities. Major participants include:

- NRECA's Cooperative Research Network
- Pacific Northwest National Laboratories
- Carnegie Mellon University
- Cigital, Inc.
- Honeywell Corporation.

Solar and Distributed Generation

Solar Utility Networks: Replicable Innovations in Solar Energy (SUNRISE)
SunShot, Energy Efficiency and Renewable Energy (EERE)
SUNDA (Solar Utility Network Deployment Acceleration):
This CRN led $4.8M 4-year project has 16 co-ops and includes DOE award of $3.6M. The co-ops will work with the project team to develop to develop a standard "PV system package" consisting of engineering designs, financing and insurance packages, optimized procurement and training.

Objectives of Project
The project will collaborate with Rural Electric Co-ops to develop tools and processes to reduce barriers to implementation of utility-owned, utility-scale PV systems. It will develop and streamline these "business products" through implementation of a minimum of 22.75 MW of PV at 16 co-ops. Extensive training and outreach materials will be developed and delivered to reach balance of 900 co-ops plus other interested utilities. Participating co-op states are indicated below.

Grid Engineering for Accelerated Renewable Energy Deployment (GEARED)
Energy Efficiency and Renewable Energy (EERE)
GEARED – Training and Analytical Tools for High Penetrations of Solar and DG:
This project will help prepare students and current electric utility staff for high penetrations of solar and other distributed energy technologies. NRECA is a team member for a $7.3 million 4-year project to create online and in-person training modules for students and practicing utility engineers. NRECA's Cooperative Research Network will leverage DOE's investment in the grid analytics tool, the Open Modeling Framework.

Major Participants
- Missouri University of Science & Technology, Rolla, MO
- University of Illinois, Urbana, IL
- University of Wisconsin, Madison, WI
- Iowa State University, Ames, IA
- Ameren Corporation, St. Louis, MO
- City Utilities, Springfield, MO
- National Rural Electric Cooperative Association

Smart Grid

DOE Office of Electricity Delivery & Energy Reliability
NRECA – DOE Smart Grid Demonstration Project:
NRECA is in the last year of its $63M demonstration with 23 cooperatives in11 states. The project has installed and is studying a broad range of advanced Smart Grid technologies. Work has included cyber security and interoperability enhancements and 11 studies on the enabling technologies of the smart grid, demand response, and distribution automation. The project also has produced an online tool that evaluates technologies using multiple models and compares the results. NRECA and DOE have been coordinating closely on advancing grid analytics.

CRN

Cooperative Research Network

COOPERATIVE-LED RESEARCH: SMART GRID STUDIES AND LESSONS LEARNED

The National Rural Electric Cooperative Association is executing a $68 million Smart Grid Demonstration Project with a Department of Energy contribution of $34 million. Twenty-three electric cooperatives participated in this project led by the Cooperative Research Network. The project installed and studied a broad range of advanced Smart Grid technologies and advanced cyber security and MultiSpeak® interoperability. Technologies deployed included three major classes with four technology types each:

Enabling Technologies:	Advanced Metering Infrastructure Telecommunications	Meter Data Management Systems Supervisory Control and Data Acquisition
Demand Response:	In-Home Displays & Web Portals Prepaid Metering	Demand Response Over AMI Interactive Thermal Storage
Distribution Automation:	Renewables Integration Advanced Volt/VAR Control	Smart Feeder Switching Conservation Voltage Reduction

Reports and case studies may be downloaded at www.nreca.coop/smartgrid. This research is available for widespread distribution to cooperative members and non-members.

Multi-Tenant Meter Data Management – A Systems Approach to Hierarchical Value
Great River Energy and the National Information Solutions Cooperative created a secure information sharing framework. The multi-tenant data management system allows the G&T's member systems to collaborate and coordinate their DR resources with greater agility. Through the system, GRE has enabled its distribution cooperatives to achieve the benefits and economies of scale, while maintaining local control.

Costs and Benefits of Smart Feeder Switching – Quantifying the Operating Value of SFS
Nine rural electrical cooperatives deployed distribution automation technologies in Smart Feeder Switching (SFS) applications. The research defined an analytical methodology for quantifying the value of two SFS operational benefits – rapid restoration following a fault and reduced II_2RR losses through feeder load balancing. Projected values were compared with field study results from the participants. From this, a logical modeling framework was defined for assessing SFS costs and benefits.

Costs and Benefits of Conservation Voltage Reduction – CVR Warrants Careful Examination
Four rural electrical cooperative utilities deployed conservation voltage reduction (CVR) technology. Data from the field studies of the technology were used for the development and calibration of a hybrid power flow-economic model. A methodology for cost-benefit analysis of conservation voltage reduction was derived, with the largest and clearest payback coming from peak demand reduction, the benefit of most interest to the cooperatives studied. Additional benefits were reductions in losses and energy requirements.

Demand Response & Critical Peak Pricing – Testing the Theoretical Basis for DR
Demand response (DR) programs were deployed at several cooperatives under the demonstration project. Consumer- or cooperative-initiated actions to affect end-use activity can provide several benefits to the electric system. A guiding econometric analysis and modeling approach was prepared. Initial findings relate to implementation issues, and results from the demonstration will help test the validity of previously hypothesized demand response models. Enhancements from the research can provide for estimation of distribution system losses and the interrelationship of distribution automation with demand response.

Conservation Impact of Prepaid Metering – Motivation and Incentives for Pre-Pay Systems
The motivation for prepayment programs vary among cooperatives. Three distribution cooperatives were tasked with implementing prepay under the demonstration project and are examined to provide an overall status for each program, as well as compare and contrast the results of each. In general, the investigation corroborated the basic tenants of prepayment as stated in previous work, including high degrees of member satisfaction, appreciation of alternatives, greater implementation options through vendor support, and better

energy awareness. The issue of conservation was somewhat difficult to validate based on the data available but the perception of conservation was very prominent with participants surveyed.

Energy Storage – The Benefits of "Behind-the-Meter" Storage
Behind-the-meter energy storage refers to devices and services that allow for storage internal to homes or commercial buildings. Energy storage can be valuable in addressing frequency regulation, demand response, "valley filling" of off-peak loads and other services and is poised to become an important element of the electricity infrastructure. Deployment of energy data management coupled with energy storage systems enables smart devices to provide both traditional and non-traditional storage services, including emergency power and grid support. Two related behind-the-meter projects involved distribution co-ops and a G&T to validate the technologies and determine their value for demand reduction and provision of key ancillary services like frequency regulation.

Washington-St. Tammany Case Study – Stress-Testing Designs Before Deployment
A case study of one cooperative's communications installation illustrates success in the face of unexpected developments. Lessons can be learned from this demonstration project, including the win-win from re-evaluating and reconsidering the original proposed communication design.

Delaware County Electric Cooperative – DR Capability and Predictability
A demand response program to shed load when requested by an independent system operator was instituted by a one of the demonstration participants. This case study describes implementation of advanced metering infrastructure and load control switches to accomplish the intended beneficial result.

AMI-Based Load Research – KIUC Demonstration
The implementation of an advanced metering infrastructure provided the vehicle for a first-ever system-specific load research program. The expectations a robust evaluation of system load characteristics for both rate studies and system engineering are examined from the case study of the load research demonstration.

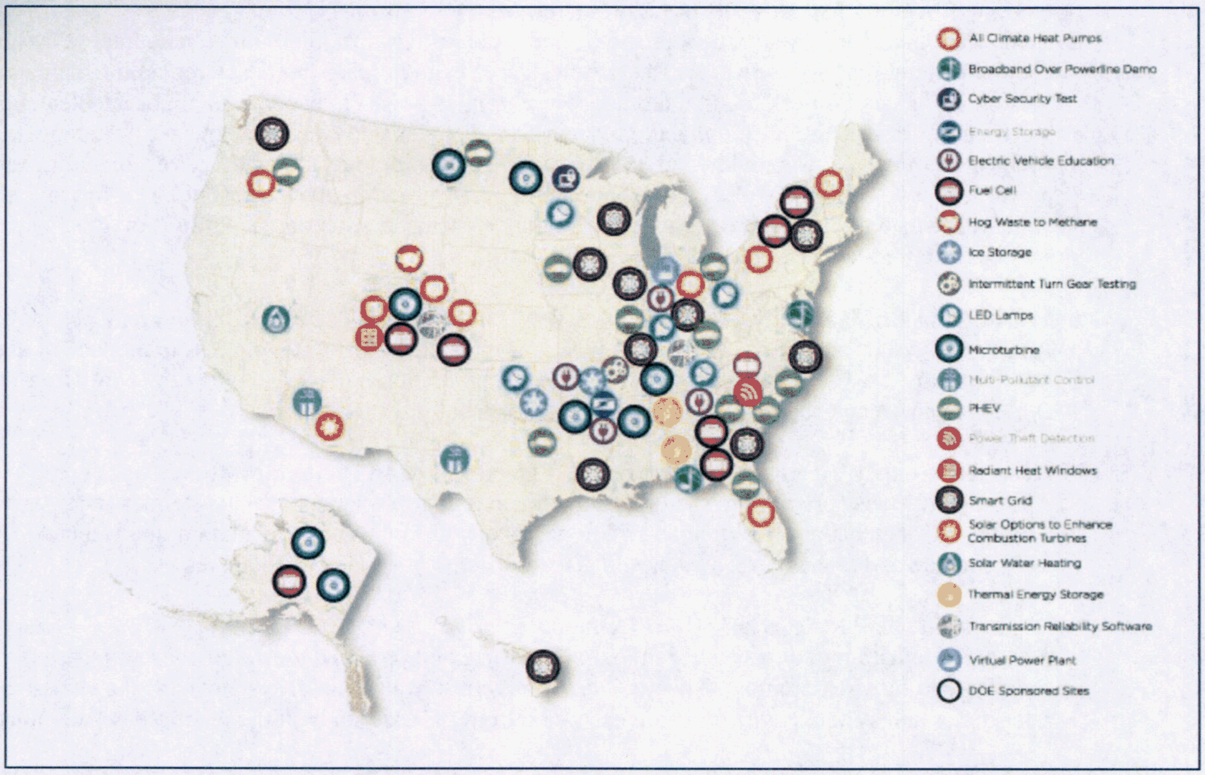
Smart Grid and the Emergence of a Consumer-Centric Utility
Much of the policy analysis surrounding smart grid has focused on the transformation of the nation's electric system from an electro-mechanical system to a digital system; less discussed but equally important is not only how the smart grid is transforming the relationship between the utility and its customers, but also the need for changing this relationship. The NRECA demonstration project illustrated the difficulties and benefits of communicating and engaging with consumers in a new way.

Communications – The Smart Grid's Enabling Technology
Communications were affirmed as an indispensable enabling technology for any fully implemented Smart Grid. Identified as one of the four enabling technologies deployed in the demonstration, the other three were readily seen to be dependent on telecommunications to some degree. Each required the movement of great volumes of data from one point to another. Insights were gleaned from the co-ops that took part in the demonstration, particularly the decision-making processes, providing a backdrop for defining the communication requirements of current and future smart grid applications and the additional research needed on decision processes.

CRN®

Cooperative Research Network

Depiction of CRN Research Demonstrations with Co-ops Around the Nation



4301 WILSON BOULEVARD | ARLINGTON, VA 22203-1860 | 703.907.5843
WWW.COOPERATIVE.COM/CRN *(membership website)* | **WWW.NRECA.COOP** *(public website)*

National Rural Electric Cooperative Association
A Touchstone Energy® Cooperative

CRN

Cooperative Research Network

Sample of CRN TechUpdate Electronic Newletter

CRN *Cooperative Research Network*

TechUpdate

February 20, 2014

QUICK LINKS

- CRN Homepage
- Archive of Tech Updates and E-Updates
- Forward to a Friend
- Print friendly version
- Contact CRN

TechAdvantage Conference and Expo: March 3-6

March 3-6 is NRECA's annual TechAdvantage Conference and Expo in Nashville, TN. Join CRN for workshops on Grid Resiliency, Open Modeling Framework, Cyber Security, Solar PV, Energy Storage, Smart Feeder Switching, Next Generation IT Architecture, System Loss Reduction...and more! Register here.

Top 20 Technologies and Trends of 2013

It's been another exciting year in the world of energy-efficiency technologies. There has been rapid maturation of light-emitting diodes (LEDs), the introduction of new gas technologies, and an enormous surge in the number of available energy analytics tools. Read this E Source review of twenty of the best energy efficiency technologies and trends in 2013.

New TechSurveillance: Consumer Guide to Energy Efficient New Homes

Becoming the owner of a newly-constructed home is an exciting process and can be a major life milestone – and also necessitates making a lot of important decisions. Use this Consumer Guide to help your consumer members understand their options for energy efficiency when building or buying their new home. It explains the benefits of an energy efficient home, provides tools to help make smart energy decisions throughout the building or buying process, and identifies additional information resources.

Identifying Cost-Effective Applications for Motor Voltage Controllers

Voltage controllers are electronic devices that sense the load on a motor and reduce the voltage applied to the motor's terminals when it is operating at low load. While there are extravagant claims about energy savings from voltage controllers, cost effective applications for these devices are few and far between. Read about what is required for a cost-effective application for motor voltage controllers.

LED Applications: Tubes and Troffers

Fluorescent troffers are the most common type of lighting fixture found in US commercial facilities, accounting for 50 percent of the luminaires in place. Because linear fluorescent lamps are efficient, long-lasting, and relatively inexpensive, it has been difficult for light-emitting diode (LED) makers to break into this market... until now. Find out why the tide appears to be turning in favor of LEDs for some types of troffer products.

Prioritization in Asset Management

Members have indicated that an important element of Asset Management is consistent prioritization of assets. However, there is uncertainty about the global picture of the industry at present - which prioritization strategies are being used, required inputs, which assets are part of the utility programs, success rates, etc. Learn more about asset prioritization.

Retrocommissioning Programs: Five Tips for Boosting

CRN

Cooperative Research Network

Presentation Title	Date	Time	Session #
Choosing the Right Frequency for Your Communications Project	3/5/2014	8:15 a.m. - 9:15 a.m.	Learning Lab 2F
Supplier Alliances: An Alternative Approach	3/5/2014	8:15 a.m. - 9:15 a.m.	Learning Lab 2G

Learning Labs 3

Presentation Title	Date	Time	Session #
Transitioning from Legacy AVL to a Utility-Specific Solution	3/5/2014	2:00 p.m. – 3:15 p.m.	Learning Lab 3A
GIS Modeling For Hazard Tree Control	3/5/2014	2:00 p.m. – 3:15 p.m.	Learning Lab 3B
Smart Grid Project – Stanton/Cuming	3/5/2014	2:00 p.m. – 3:15 p.m.	Learning Lab 3C
Cooperatives Bring the Solar Energy Future to Their Communities	3/5/2014	2:00 p.m. – 3:15 p.m.	Learning Lab 3D
Cyber Security for Critical Infrastructure	3/5/2014	2:00 p.m. – 3:15 p.m.	Learning Lab 3E
Top 10 Mobile Device Management Suites You Need to Know	3/4/2014	10:15 a.m.- 11:30 a.m.	Learning Lab 3F
Facilities Management Best Practices	3/5/2014	2:00 p.m. – 3:15 p.m.	Learning Lab 3G
Contracting Cloud Services – A Guide to Best Practice	3/5/2014	2:00 p.m. – 3:15 p.m.	Learning Lab 3H
Evaluating and Applying Utitliy-Scale Energy Storage - Part 1	3/5/2014	2:00 p.m. – 3:15 p.m.	Learning Lab 3I

CRN

Cooperative Research Network

Presentation Title	Date	Time	Session #
LED Lighting - The Good and the Bad	3/6/2014	8:00 a.m. – 9:00 a.m.	Learning Lab 5H

Learning Labs 6

Presentation Title	Date	Time	Session #
Standing up to the Smart Grid: What is the Next Generation IT Architecture?	3/6/2014	9:15 a.m. – 10:30 a.m.	Learning Lab 6A
Cable Rejuvenation Life Extensions Estimates	3/6/2014	9:15 a.m. – 10:30 a.m.	Learning Lab 6B
Closing the Loop on Conservation Voltage Reduction	3/6/2014	9:15 a.m. – 10:30 a.m.	Learning Lab 6C
Integration Issues and Simulation Challenges of High-Penetration PV	3/6/2014	9:15 a.m. – 10:30 a.m.	Learning Lab 6D
Just How Sensitive is Your Information?	3/6/2014	9:15 a.m. – 10:30 a.m.	Learning Lab 6E
Time to Get Serious About Technology Integration & Interoperability	3/6/2014	9:15 a.m. – 10:30 a.m.	Learning Lab 6F
Mitigating Risk with Insurance and Contract Language	3/6/2014	9:15 a.m. – 10:30 a.m.	Learning Lab 6G

Learning Labs 7

Presentation Title	Date	Time	Session #
Build Communication Bridges Across Your Organization with Work Management System	3/6/2014	10:45 a.m. - 11:45 a.m.	Learning Lab 7A
Systems Loss Reduction	3/6/2014	10:45 a.m. - 11:45 a.m.	Learning Lab 7B
Securing Electric Utility Control System Assets and Networks	3/6/2014	8:00 a.m. – 9:00 a.m.	Learning Lab 7C
Time to Get Serious About Technology Integration & Interoperability - A Panel Discussion	3/6/2014	10:45 a.m. - 11:45 a.m.	Learning Lab 7D
Asset Recovery/Surplus	3/6/2014	10:45 a.m. - 11:45 a.m.	Learning Lab 7E

CRN®
Cooperative Research Network

Presentation Title	Date	Time	Session #
Deploying Cloud-Based Technology To Eliminate Recurring PPE Costs	3/4/2014	3:00 p.m. – 3:20 p.m.	Techno 4
Latest in iOS Tech for Field Inspection	3/4/2014	3:00 p.m. – 3:20 p.m.	Techno 4
Developing a Fiber-to-the-Home (FTTH) - Lessons Learned	3/4/2014	3:00 p.m. – 3:20 p.m.	Techno 4
Wood Pole Strength for all NESC Weather Conditions	3/4/2014	3:00 p.m. – 3:20 p.m.	Techno 4
A Step-wise Approach to Feeder Automation	3/4/2014	3:30 p.m. – 3:50 p.m.	Techno 5
Distributed Volt/Var Application– The Good, the Bad and the Solution	3/4/2014	3:30 p.m. – 3:50 p.m.	Techno 5
Leverage Your Prepaid System to Reduce and Manage Bad Debts	3/4/2014	3:30 p.m. – 3:50 p.m.	Techno 5
Demand Response: Benefits for the Member and the Operations Department	3/4/2014	3:30 p.m. – 3:50 p.m.	Techno 5
The Time is Ripe for Accelerated Pre-Pay Deployments	3/4/2014	4:00 pm. – 4:20 p.m.	Techno 6
Building a Better Transmission System for the Next Super Storm	3/4/2014	4:00 pm. – 4:20 p.m.	Techno 6
Monitoring and Reporting of Renewable Resources	3/4/2014	4:00 pm. – 4:20 p.m.	Techno 6